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Investigation of Wetland Performance for Sewage Treatment in Rural Areas

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ABSTRACT

Sewage before treatment causesharm to the environment through pollution of water, soil, air sources and all things that matter for better living. Infection through crude sewage disposal in the environment can cause epidemic and spread of dangerous diseases. Further, it also infects water and soil sources through organic and mineral substances and heavy metals, which can cause irrecoverable damage through diseases like cancer in humans and animals in the long run. Sewage treatment leadingto recyclable water for agricultural use affairs and green space. This is of extraordinary importance in arid reasons because of finite amount of recoverable water even in rainy years.

Keywords: *Sewage, Environment, Heavy Metals*

INTRODUCTION

Nowadays there exists an expanded range of sewage systems that can be used for sewage treatment. However, there are major problems with some of the commonly used mechanized systems for sewage treatment, such as high cost of construction, high level of energy consumption, requirement of sludge disposal, and use of high technology for complicated utilization and treatment. Construction of advanced refineries in rural areas aren't welcomed because of lack of specialists for utilization and high cost of construction. The objective of this article is to introduce a suitable system to construct sewage treatment in rural areas.

Sewage treatment by the wetland method is much more affordable. Annual fees, such as fund, utilization, repair and maintenance and depreciation are low for this method. Utilization is quite and the only mechanical appliances are pumps and piping for sewage transport. Artificial wetlands have been introduced for 60 years, especially in the last 30 recent years, and the tendency touse this technology is easily available. Unfortunately, many developing countries are turning to high technologies used in developed countries instead of inexpensive and locally suitable systems. Further, due to the many problems associated with technologies, the users are confronted with many problems, such as utilization, maintenance, high power consumption, etc. However, because of lack of efficiency and power requirements of these systems, natural systems are noticeable these days in developed countries.

Wetlands are used as a secondary purification unit and are usually constructed after dirt stuck, piece stuck and primary settlement units and wetland treatment process is illustrated in figure (1).

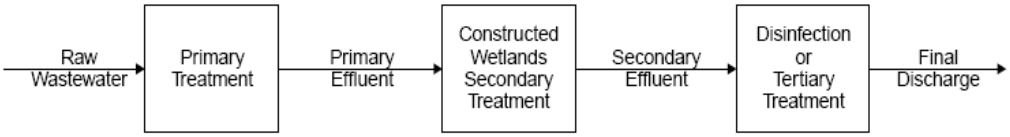

Figure1. *Process of wetland treatment*

Wetlands are divided into two groups:

1- Natural wetlands

2- Artificial wetlands

In natural wetlands, plants such as straw and etc. grow automatically in stored sewage such as swamplands and sewage is treated uncontrolled. Artificial wetlands are designed systems which were presented in the 1950s in West Germany. Artificial wetlands are of two types:

1- Artificial wetlands with surface flow where the liquid surface is in touch with air and which use soil and other suitable environment to raise plants.

2- Artificial wetlands with sub-surface flow where the liquid flow is under the surface of sand or gravel.

In the surface method, sewage flows on the ground surface. This method is not recommended because of problems, such as mosquitos and flies that growing and the production of smell in many areas. In the sub-surface method, sewage goes through the layers below the surface and surface of wetland may be completely dry. This method doesn't have those mosquitos and flies growing and smell production problems. The sewage entering the wetland should be pre-treated through the settlement. Components of an artificial wetland system are as shown in figure (2).

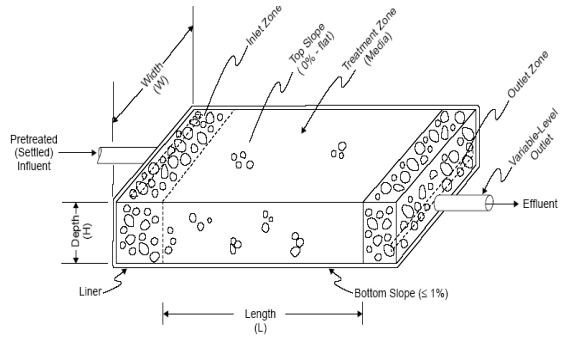

Figure2. *Components of an artificial wetland system*

As shown in figure (2), the main components of a wetland system are [figure (3)]:

1- Incoming pipe

2- Clay and combination membrane and membrane process over pond's length.

3- Weak materials for pond filling

4- Planted vegetation

5- Exhaust pipe and control system of water surface.

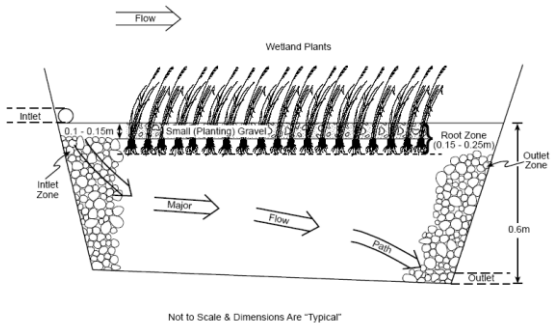

Figure3. *Components of a wetland system*

ADVANTAGES OF USING PLANTS

Plants that grow in a wetland help with treatment in several ways:

Oxygen Transfer

Plants transfer oxygen from leaf to root. This operation is done to grow roots and Phytotoxic decomposition (toxic substances around the roots). This operation helps aerobic bacteria around the roots to decompose organic substances of sewage.

Increase in Penetrability of Wetland Layers

The root penetration into the soil causes not only the water move around the root, but also destruction and rotting of old roots and provides some orifices for water transition.

Nitrogen and Phosphorus Pick Up

Nitrogen and phosphorus are picked up through the layers of wetlands (approximately 20 percent of nitrogen).

Evaporation and Transpiration

Evaporation and transpiration causes the reduction of sewage volume.

Insulation

One of the advantages of plants in the system is their role as insulation in cold seasons.

Plants in wetlands can be the operator of simplification in gas transition into and out of sewage. Studies show the role of oxygen import is more. However, plants cause the methane gas and other dissolved gases of sewage to exit.

The amount of oxygen transition through the roots of plant depends on many factors, such as dissolved oxygen density in sewage, depth of roots in sewage, air, and temperature of leaf. The rate of oxygen transition (CO2) by plants is between 0 and 3 (g-O/m^2-d) which is very low to be able to provide all of the necessary oxygen for an under irrigation system.

Roots of plants in wetlands play an effective role in attracting phosphorus and nitrogen and metals and plants transmit their nutrients by roots and stem. Studies show that nitrogen absorption (N2) by plants is between 12 and 20 (gN/m^2-y) and phosphorus absorption is equal to 1.8to18 (gP/m^2-y) but the rate of absorption depends on the type of plants. For example, the minimum and maximum values of these factors belong to straw plants and bulrush. The rate of phosphorus, nitrogen and metal deletion varies with time and most of the nutrient absorption by plants occurs in the growing season, that is mid spring and summer.

Disposal of sewage pollutants by wetland system:

Wetland treats sewage by physical, chemical and biological processes. The quality of sewage discharge depends on many parameters some of which are not measurable and only some parameters such as internal system parameters are helpful. For example, properties of wetlands are measurable.

In diagram (1) the rate of pollutant deletion in a designed wetland system in one of the villages in the United States is illustrated. The rate of pollutant disposal by the wetland system was well and the wastewater discharge for plants irrigation had enough quality. In table (1) the quality of sewage discharge in the surface wetland system is illustrated.

In the sub-surface wetland system, the most rates of TSS are disposed in the first few meters of reactor. Also, examination shows that the rate of nitrogen in sewage is reduced by 60to86 percent in the wetland system.

Nitrification and denitrification are most important factors for sewage nitrogen reduction and these are done well in the reactor of the wetland. The rate of nitrogen in wastewater discharge with 6to7 days remaining time is less than 10 Mg in a liter [Diagram (2)].

The rate of phosphorus deletion is not well in wetland system and special materials should be used to reduce phosphorus better. Special materials mean those materials that contain iron or aluminum. Using of these materials is unaffordable and after a short time they lose their efficiency. Therefore, these materials are not recommended in wetlands.

Generally, some factors such as entrance sewage, hydraulics of entrance sewage, weather and physical factors of system are effective factors for rate of sewage discharge quality parameters.

CONCLUSION

Wetlands are an affordable and executable method for sewage treatment in different climatic zones. Their application can have a strong influence on general hygienic level at reduced cost. The following conclusions can be drawn for a wetland system:

- Low construction fee of treatment.

- Easy utilization of treatment system.

- Improving ground water quality for development of villages.

- Reduction of diseases caused by sewage.

- Increase of green spaces in villages by execution of wastewater transferring design and using for irrigation.

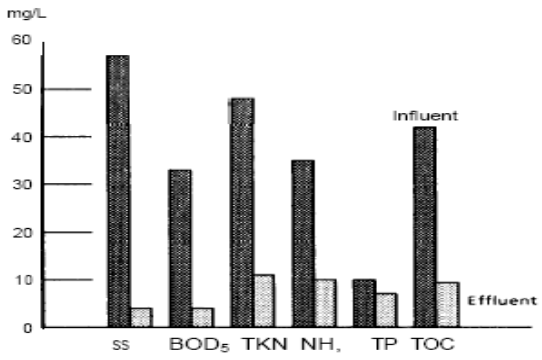

Figure4. *The rate of pollutant material deleting in wetlands system*

Table1. *Quality of discharging sewage in sub-surface wetlands system*

Table 3-5. Background Concentrations of Contaminants of Concern in FWS Wetland Treatment System Effluents

Constituent	Range (mg/L)	Typical (mg/L)	Factors Governing Value	Reference
TSS	2-5	3	Plant types, coverage, Climate, wildlife	Reed et al.,1995; Kadlec and Knight, 1996
BOD_5 [1]	2-8	5	Plant types, coverage, Climate, plant density	Reed et al., 1995 Gearheart, 1992
BOD_5 [2]	5-12	10	Plant types, coverage, Climate, plant density	Kadlec and Knight, 1996
TN	1-3	2	Plant types, coverage, Climate, oxic/anoxic	Kadlec and Knight, 1996 Reed et al., 1995
NH_4- N	0.2-1.5	1.0	Plant types, coverage, Climate, oxic/anoxic	Kadlec and Knight, 1996 Reed et al., 1995
TP	0.1-0.5	0.3	Plant types, coverage, Climate, soil type	Kadlec and Knight, 1996 Reed et al., 1995
Fecal Coli CFU/100 ml	50-5,000	200	Plant types, coverage, Climate, wildlife	Watson et al, 1987; Gearheart et al., 1989

[1]Wetland system with significant open water and submergent vegetation
[2]Wetland system fully covered by emergent vegetation

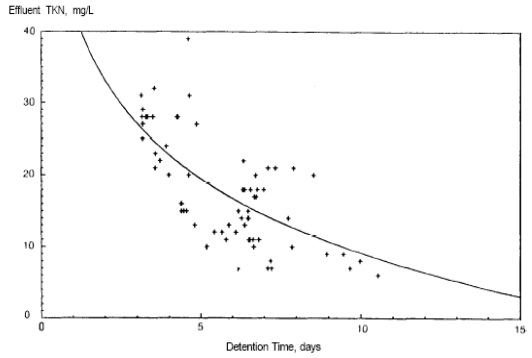

Figure5. *The rate of nitrogen in discharging wastewater with remaining time*

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